REPRESENTING AND ACCESSING DATA THAT CHANGES OVER TIME

Lydia Cupery


Progress®
Syncfusion®
alexa
Passage
TEXT CONTROL
DG
THE DENZEL GROUP
Making I.T. Happen
uno
PLATFORM
Cloudinary
AKKODIS
LUTRON®
CIOReview
CODE
CIOINSIGHTS
Insights From Technology Leaders
devIT:>_
I AM TIM COREY
ENERGYCAP
aws professional services
keebo
The New York Times
ATOMIC OBJECT
redis

STABLE ATTRIBUTES

(THESE THINGS PROBABLY WON'T CHANGE ANYTIME SOON!)

MY NAME IS LYDIA

I LOVE PITA BREAD 🥙

I WAS BORN IN ISTANBUL

VARIABLE ATTRIBUTES

(THESE THINGS MIGHT REMAIN THE SAME, OR THEY MIGHT CHANGE IN THE NEXT FEW YEARS)

I LIVE IN ZEELAND, MICHIGAN

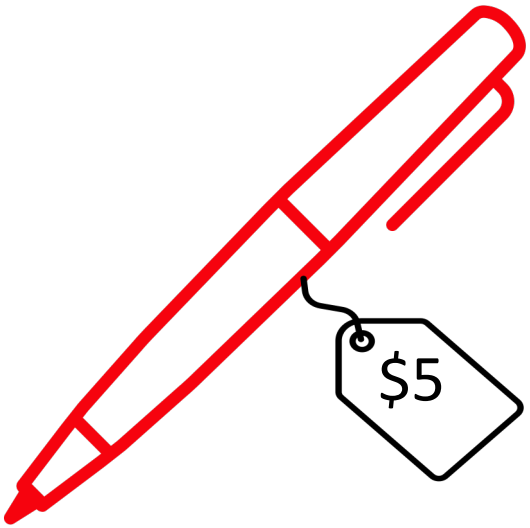
MY FAVORITE SHOW IS ATYPICAL

I HAVE ONE NEPHEW

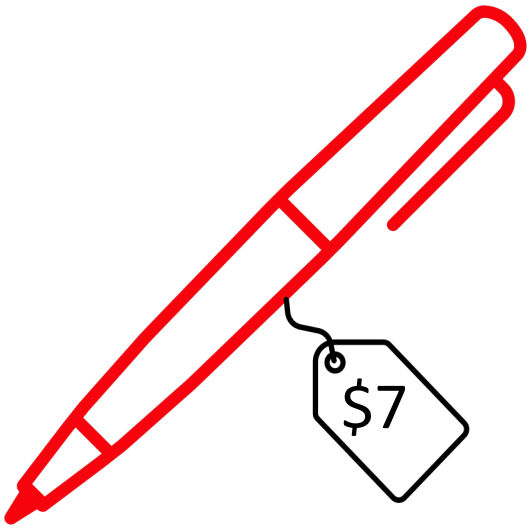
LET'S LOOK AT SOME EXAMPLES

A lot of things could have attributes that change over time

FOR EXAMPLE, A PRODUCT:



2001-2015



2015-2020

2020 - now

FOR EXAMPLE, A LOAN:

2017-2018
Interest Rate: 4.25%

2019-2021
Interest Rate: 3%

2022 - infinity
Interest Rate: 7%

HOW WE REPRESENTED ATTRIBUTES THAT CHANGE OVER TIME

Creating separate base and versioned tables

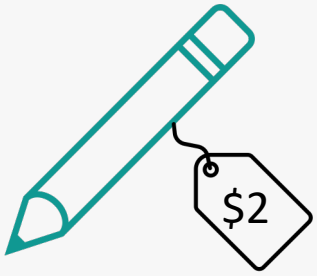
The Fancy Scribbler

2001-2015

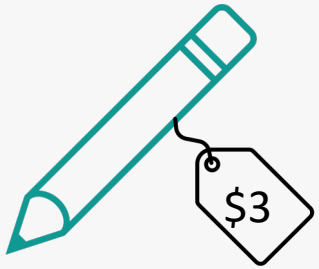
2016-2020

2021 - infinity

The 2D Printer



2001-2017



2018 - infinity

Id	Base Identifier	Name	Price	Color	Effective Date Range
1	1	Fancy Scribbler	$5.00	Red	1/1/2001 – 12/31/2015
2	1	Fancy Scribbler	$7.00	Red	1/1/2016 – 12/31/2021
3	1	Fancy Scribbler	$7.00	Yellow	1/1/2021 – NULL
4	2	2D Printer	$2.00	Blue	1/1/2001 – 12/31/2017
5	2	2D Printer	$3.00	Blue	1/1/2018 – NULL

STABLE

Identifier	Name
1	2D Printer
2	Fancy Scribbler

VARIABLE

Base Identifier	Price	Color	Effective Date Range
1	$5.00	Red	1/1/2001 – 12/31/2015
1	$7.00	Red	1/1/2016 – 12/31/2021
1	$7.00	Yellow	1/1/2021 – NULL
2	$2.00	Blue	1/1/2001 – 12/31/2017
2	$3.00	Blue	1/1/2018 – NULL

WHAT IS THE INFO FOR THE PEN WITH IDENTIFIER 1 ON JANUARY 15, 2016?

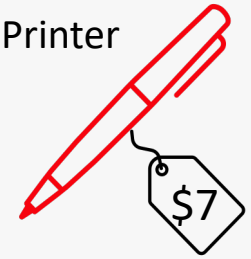
STABLE

Identifier	Name
1	2D Printer
2	Fancy Scribbler

VARIABLE

Base Identifier	Price	Color	Effective Date Range
1	$5.00	Red	1/1/2001 – 12/31/2015
1	$7.00	Red	1/1/2016 – 12/31/2021
1	$7.00	Yellow	1/1/2021 – NULL
2	$2.00	Blue	1/1/2001 – 12/31/2017
2	$3.00	Blue	1/1/2018 – NULL

2D Printer



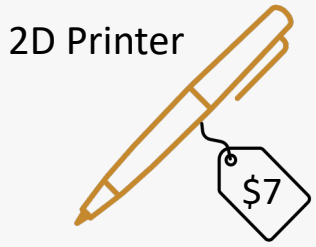
WHAT IS THE INFO FOR THE PEN WITH IDENTIFIER 1 ON JANUARY 15, 2021?

STABLE

Identifier	Name
1	2D Printer
2	Fancy Scribbler

VARIABLE

Base Identifier	Price	Color	Effective Date Range
1	$5.00	Red	1/1/2001 – 12/31/2015
1	$7.00	Red	1/1/2016 – 12/31/2021
1	$7.00	Yellow	1/1/2021 – NULL
2	$2.00	Blue	1/1/2001 – 12/31/2017
2	$3.00	Blue	1/1/2018 – NULL



WHAT IS THE INFO FOR THE PEN WITH IDENTIFIER 2 ON JANUARY 1, 2015?

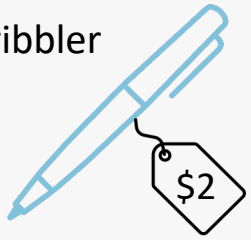
STABLE

Identifier	Name
1	2D Printer
2	Fancy Scribbler

VARIABLE

Base Identifier	Price	Color	Effective Date Range
1	$5.00	Red	1/1/2001 – 12/31/2015
1	$7.00	Red	1/1/2016 – 12/31/2021
1	$7.00	Yellow	1/1/2021 – NULL
2	$2.00	Blue	1/1/2001 – 12/31/2017
2	$3.00	Blue	1/1/2018 – NULL

Fancy Scribbler



WHAT IS THE INFO FOR THE PEN WITH IDENTIFIER 2 ON JANUARY 15, 2021?

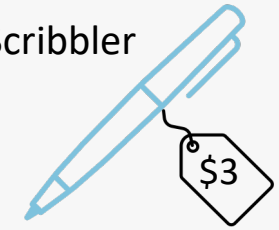
STABLE

Identifier	Name
1	2D Printer
2	Fancy Scribbler

VARIABLE

Base Identifier	Price	Color	Effective Date Range
1	$5.00	Red	1/1/2001 – 12/31/2015
1	$7.00	Red	1/1/2016 – 12/31/2021
1	$7.00	Yellow	1/1/2021 – NULL
2	$2.00	Blue	1/1/2001 – 12/31/2017
2	$3.00	Blue	1/1/2018 – NULL

Fancy Scribbler



INVARIANTS WE MAINTAINED

In order to easily look up all the versioned attributes from the versioned table for a given date, we maintain a few invariants

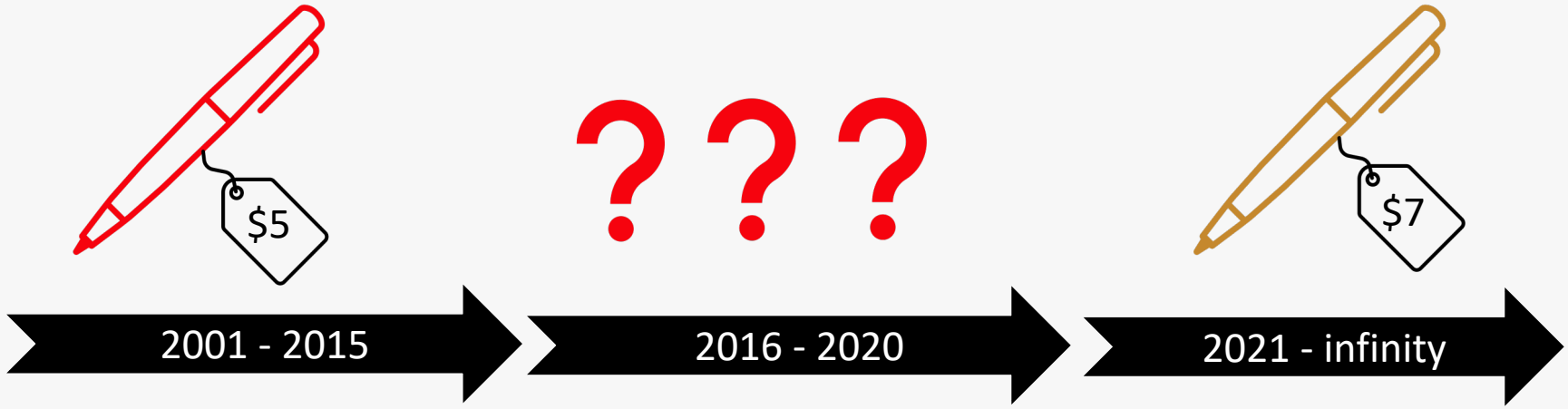
NO GAPS IN VERSIONED TABLE DATE RANGE

STABLE

Identifier	Name
1	2D Printer

VARIABLE

Base Identifier	Price	Color	Effective Date Range
1	$5.00	Red	1/1/2001 – 12/31/2015
1	$7.00	Yellow	1/1/2021 – NULL



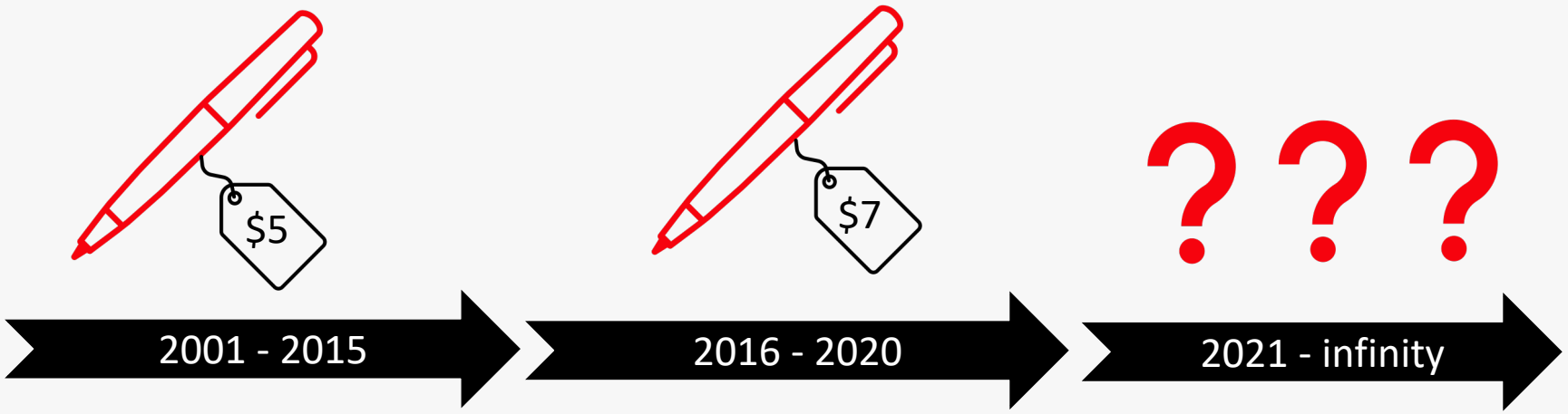
THE LAST VERSIONED RECORD IS VALID UNTIL "INFINITY"

STABLE

Identifier	Name
1	2D Printer

VARIABLE

Base Identifier	Price	Color	Effective Date Range
1	$5.00	Red	1/1/2001 – 12/31/2015
1	$7.00	Red	1/1/2016 – 12/31/2021



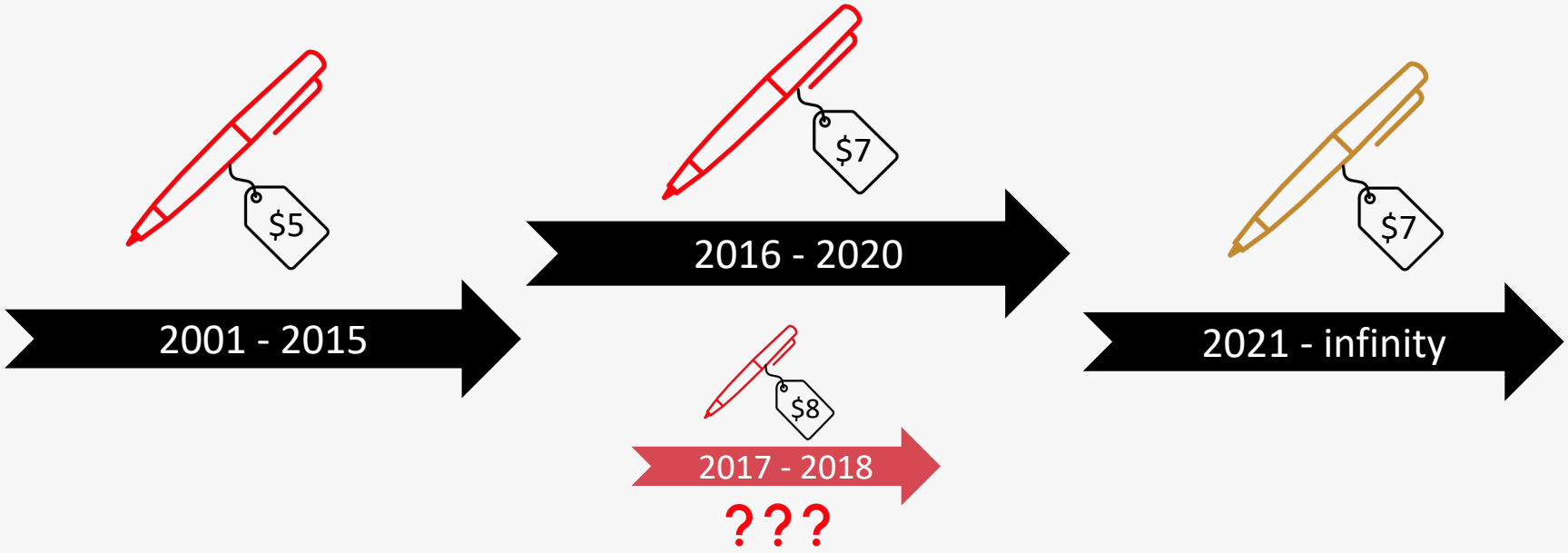
RANGES FOR VERSIONED RECORDS DO NOT OVERLAP

STABLE

Identifier	Name
1	2D Printer

VARIABLE

Base Identifier	Price	Color	Effective Date Range
1	$5.00	Red	1/1/2001 – 12/31/2015
1	$7.00	Red	1/1/2016 – 12/31/2021
1	$8.00	Red	1/1/2017 – 12/31/2018
1	$7.00	Yellow	1/1/2021 – NULL



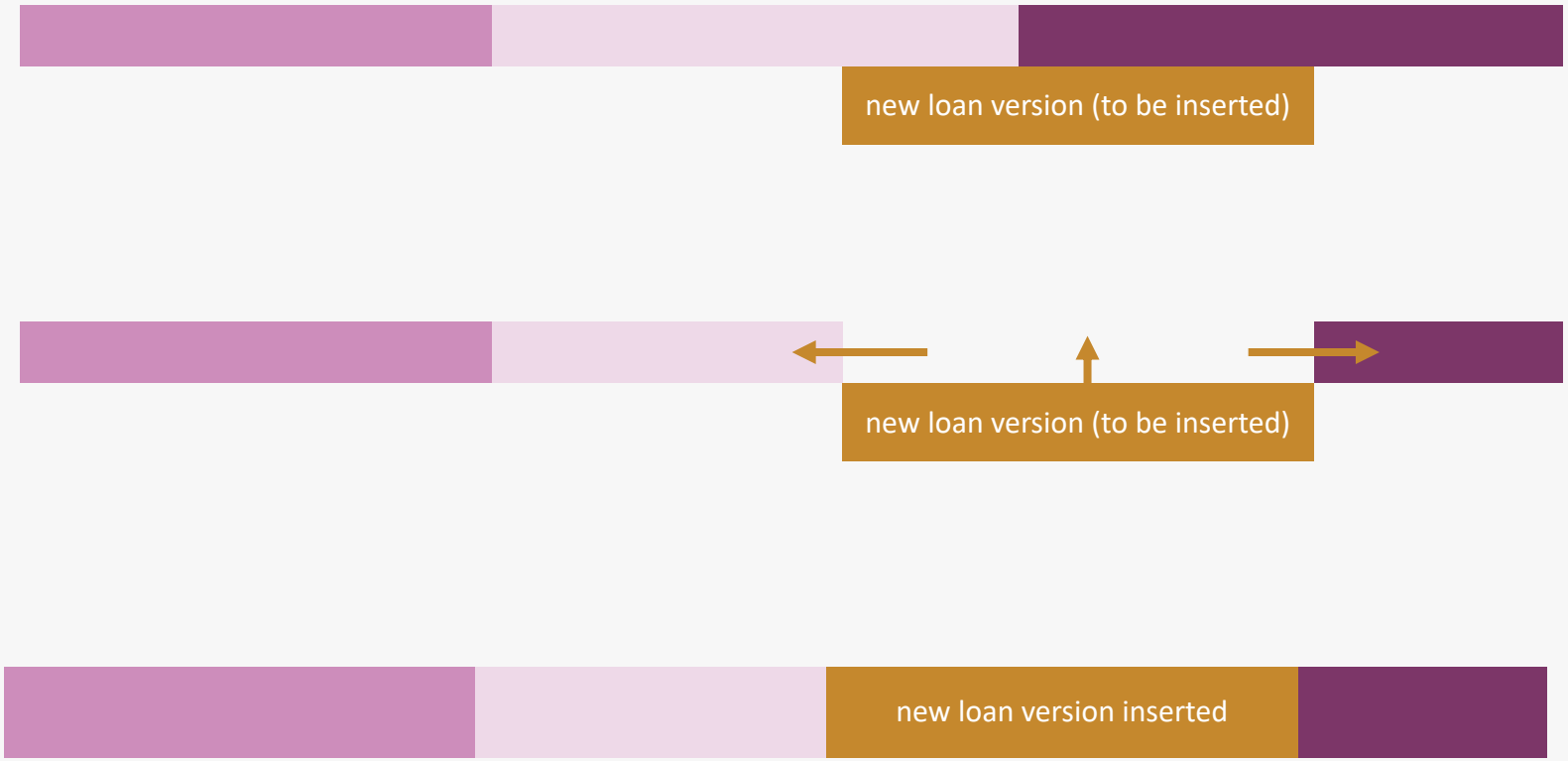
IN SUMMARY

- No Gaps in Versioned Table Date Range
- The Last Versioned Record Is Valid Until “Infinity”
- Ranges for Versioned Records Do Not Overlap

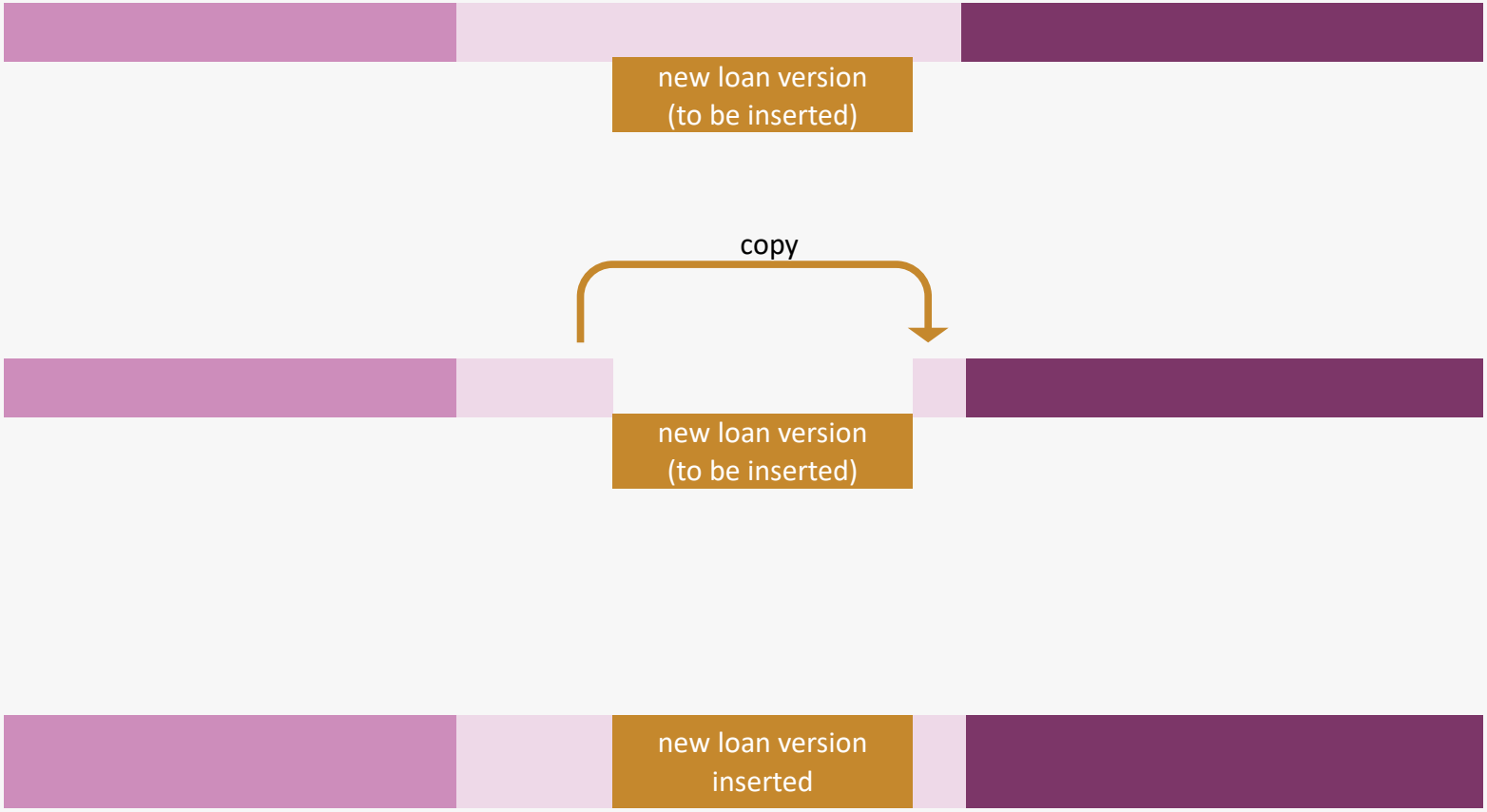
ensure there will always be exactly one versioned record for any given effective date (post the start date).

MAINTAINING THESE INVARIANTS

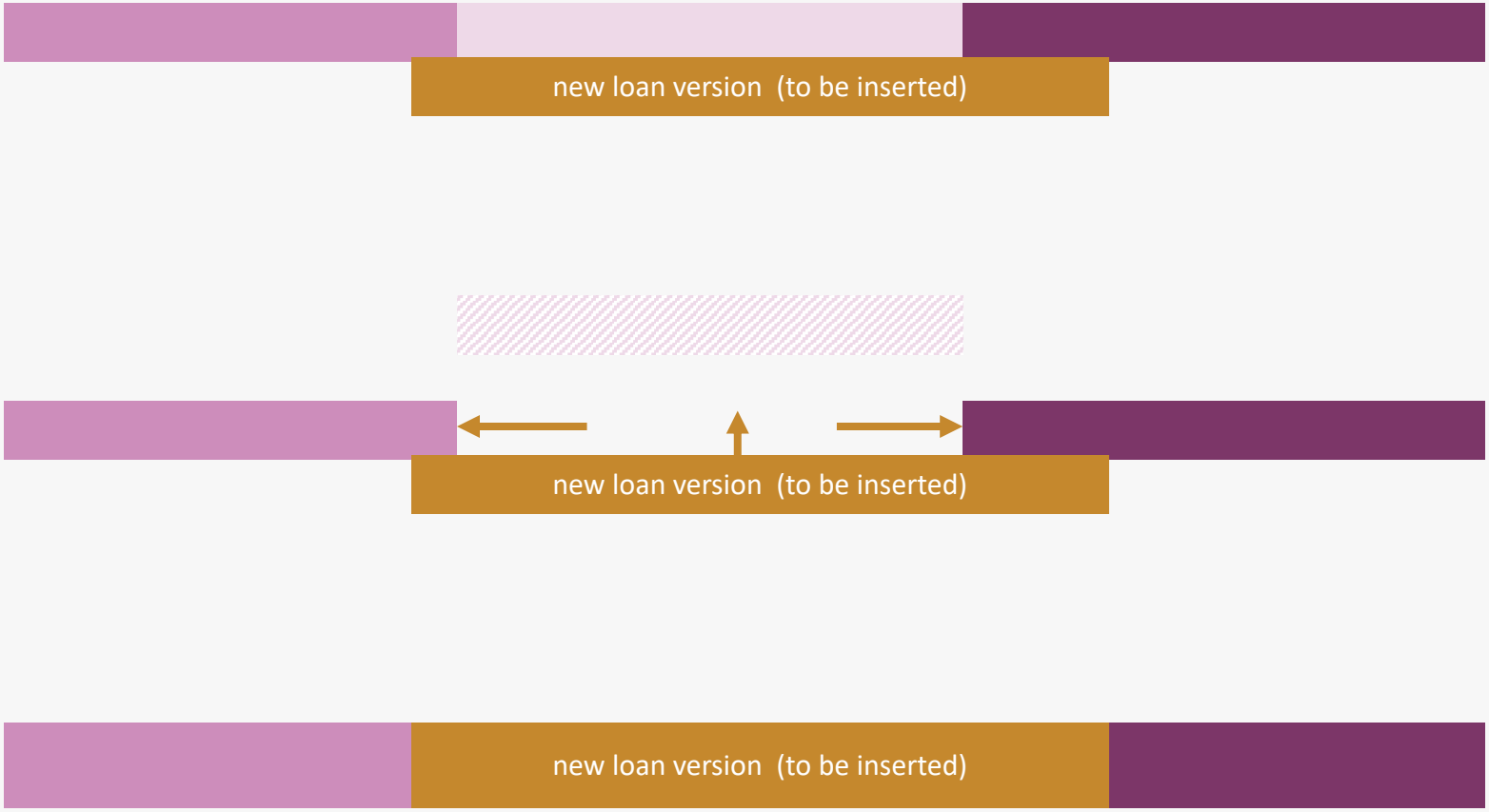
ADDING A NEW VERSION THAT OVERLAPS MULTIPLE VERSIONS



ADDING A NEW VERSION THAT OVERLAPS WITH A SINGLE VERSION



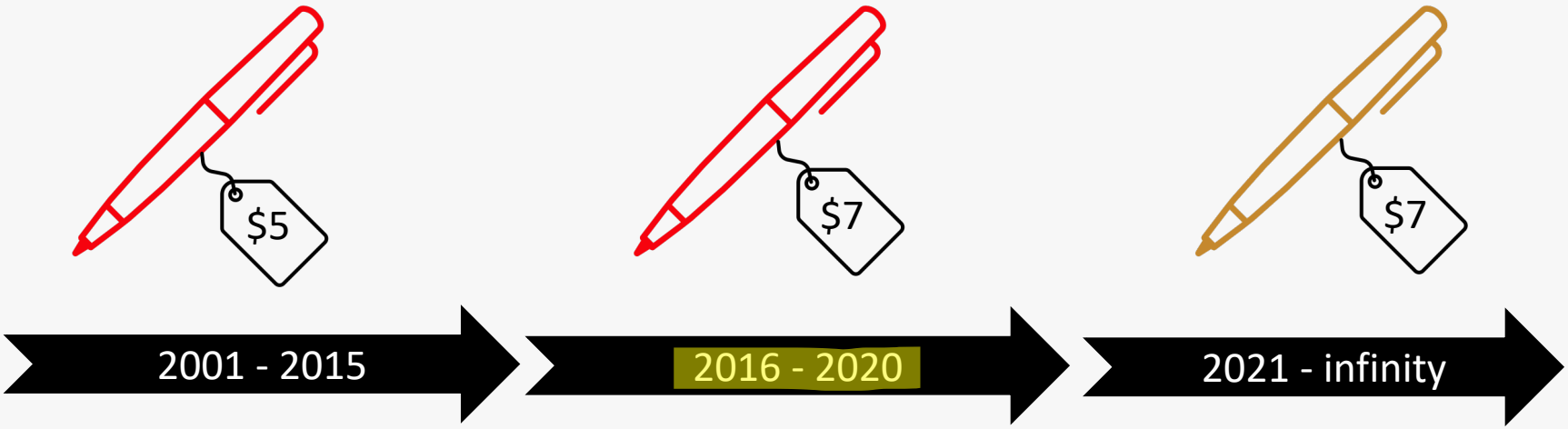
ADDING A NEW VERSION THAT CONSUMES ONE OR MORE FULL VERSIONS



LOOKING UP A RECORD WITH VARIABLE ATTRIBUTES

Providing an abstraction to look up both the stable and variable attributes of a record

WHAT ARE THE ATTRIBUTES OF PEN WITH IDENTIFIER “1” ON JANUARY 1, 2016?



Its name is “2D Printer.” It’s red and costs $7.00

WHAT ARE THE ATTRIBUTES OF PEN WITH IDENTIFIER “1” ON JANUARY 1, 2016?

STABLE

Identifier	Name
1	2D Printer

VARIABLE

Base Identifier	Price	Color	Effective Date Range
1	$5.00	Red	1/1/2001 – 12/31/2015
1	$7.00	Red	1/1/2016 – 12/31/2021
1	$7.00	Yellow	1/1/2021 – NULL

Its name is “2D Printer.” It’s red and costs $7.00

WHAT ARE THE ATTRIBUTES OF LOAN WITH IDENTIFIER “1” ON JANUARY 1,2020?

STABLE

Identifier	Name	Principal	Start At
1	Mulford Mortgage	$155,000	1/1/2017

VARIABLE

Base Identifier	Interest Rate	Extra Payment	Effective Date Range
1	4.25%	$1000	1/1/2017 – 12/31/2018
1	4.00%	$1000	1/1/2019 – 12/31/2020
1	3.00%	$1100	1/1/2021 – NULL

Its name is “Mulford Mortgage” and started 1/1/2017.
It has a principal of $155,00.
The extra payment is $1000 and the interest rate is 4.00%.

WHAT SHAPE OF DATA DO I WANT TO GET WHEN I ASK ABOUT A LOAN?

I want a row with the stable attributes:

- Name
- Principal
- Start At

And the variable attributes:

- Interest Rate
- Extra Payment
- Effective Date Time Range

STABLE

Identifier	Name	Principal	Start At
1	Mulford	$155,000	1/1/2017
2	Packard	$250,000	1/1/2017

VARIABLE

Base Identifier	Interest Rate	Extra Payment	Effective Date Range
1	4.25%	$1000	1/1/2017 – 12/31/2018
1	4.00%	$1000	1/1/2019 – 12/31/2020
1	3.00%	$1100	1/1/2021 – NULL
2	4.20%	$500	1/1/2017 – 12/31/2019
2	3.75%	$500	1/1/2020 – 12/31/2021
2	3.25%	$500	1/1/2022 – NULL

January 1, 2020 Attributes

Identifier	Name	Principal	Start At	Interest Rate	Extra Payment	Effective Date
1	Mulford	$155,000	1/1/2017	4.00%	$1000	1/1/2019 – 12/31/2020
2	Packard	$250,000	1/1/2017	3.75%	$500	1/1/2020 – 12/31/2021

STABLE VARIABLE

WHAT TYPE DO WE WANT BACK FROM THE DATABASE?

We want a row type with both the stable and versioned attributes for a specific date

January 1, 2020 Attributes

Identifier	Name	Principal	Start At	Interest Rate	Extra Payment	Effective Date Time Range
1	Mulford	$155,000	1/1/2017	4.00%	$1000	1/1/2019 – 12/31/2020
2	Packard	$250,000	1/1/2017	3.75%	$500	1/1/2020 – 12/31/2021

STABLE

VARIABLE

We want a row type with both the stable and variable attributes.

We created a SQL type to represent the above shape and called it **Loan_Type**.

CREATING A FUNCTION TO GET BACK ALL THE EFFECTIVE ATTRIBUTES

Input: Date Time

Created a “Loan Lens” function that selects both the

- base table attributes
- versioned table attributes

from the base loan table
combined (joined) with the version loan table
where the version table effective date time range
contains the inputted effective date time

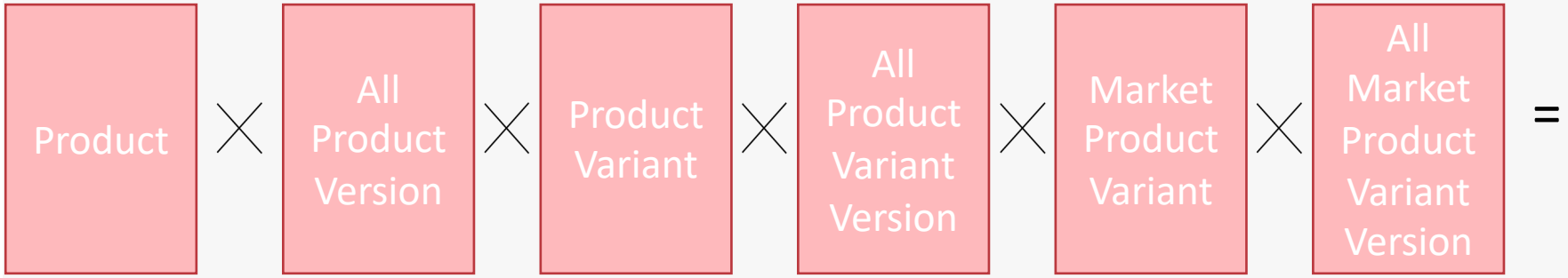
Output: Loan_Type

Identifier	Name	Principal	Start At	Interest Rate	Extra Payment	
1	Mulford	$155,000	1/1/2017	4.00%	$1000	1/1/2019 – 12/31/2020
2	Packard	$250,000	1/1/2017	3.75%	$500	1/1/2020 – 12/31/2021

STABLE

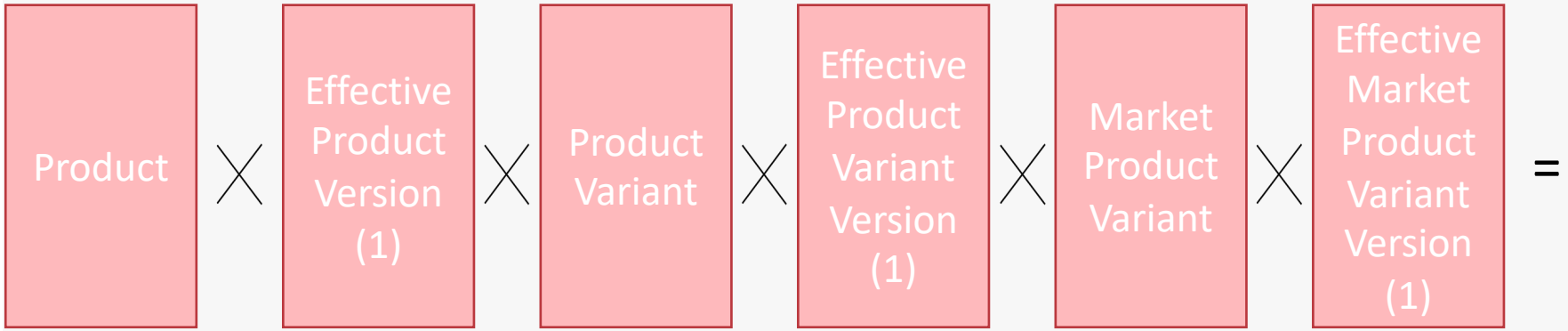
VARIABLE

When getting back all attributes



Lots and lots of records!

When getting back just the effective attributes



Just lots of records!

RECAP

1. We store the versioned attributes in a separate table

STABLE

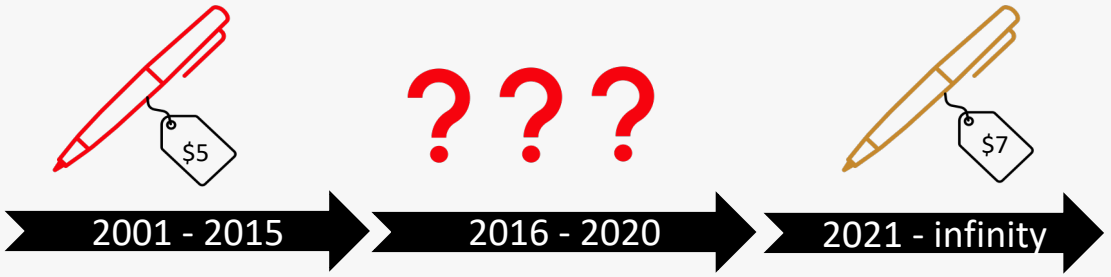
Identifier	Name	Principal	Start At
1	Mulford	$155,000	1/1/2017
2	Packard	$250,000	1/1/2017

VARIABLE

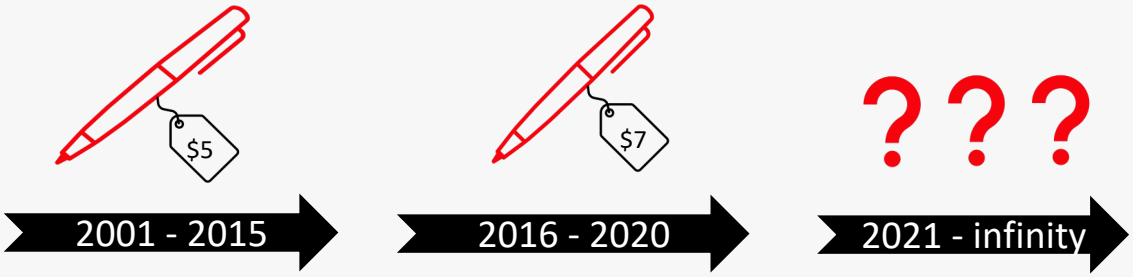
Base Identifier	Interest Rate	Extra Payment	Effective Date Range
1	4.25%	$1000	1/1/2017 – 12/31/2018
1	4.00%	$1000	1/1/2019 – 12/31/2020
1	3.00%	$1100	1/1/2021 – NULL
2	4.20%	$500	1/1/2017 – 12/31/2019
2	3.75%	$500	1/1/2020 – 12/31/2021
2	3.25%	$500	1/1/2022 – NULL

2. We maintain some invariants

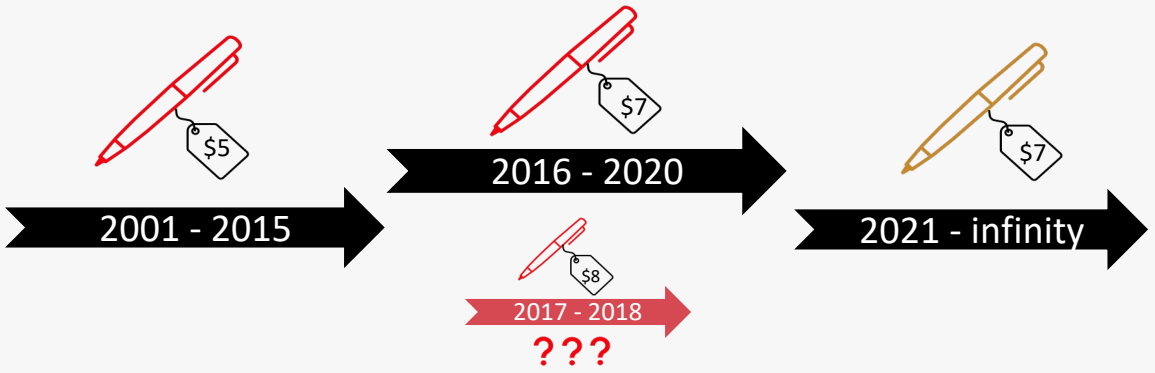
No Gaps in Versioned Table Date Range



The Last Versioned Record is Valid Until "Infinity"



Ranges for Versioned Records Do Not Overlap



3. We maintain these invariants when inserting new data

4. Encapsulate Combination of Stable and Variable Attributes

We look up the versioned attributes for the effective date from the version table and the stable attributes from the base table

STABLE

Identifier	Name	Principal	Start At
1	Mulford	$155,000	1/1/2017
2	Packard	$250,000	1/1/2017

VARIABLE

Identifier	Interest Rate	Extra Payment	Effective Date Range
1	4.00%	$1000	1/1/2019 – 12/31/2020
1	3.00%	$1100	1/1/2021 – NULL
2	3.75%	$500	1/1/2020 – 12/31/2021
2	3.25%	$500	1/1/2022 – NULL

We abstract all this at the database level – we pass the database function a date; that function is responsible for finding all the currently effective attributes for that date

Identifier	Name	Principal	Start At	Interest Rate	Extra Payment
1	Mulford	$155,000	1/1/2017	4.00%	$1000
2	Packard	$250,000	1/1/2017	3.75%	$500

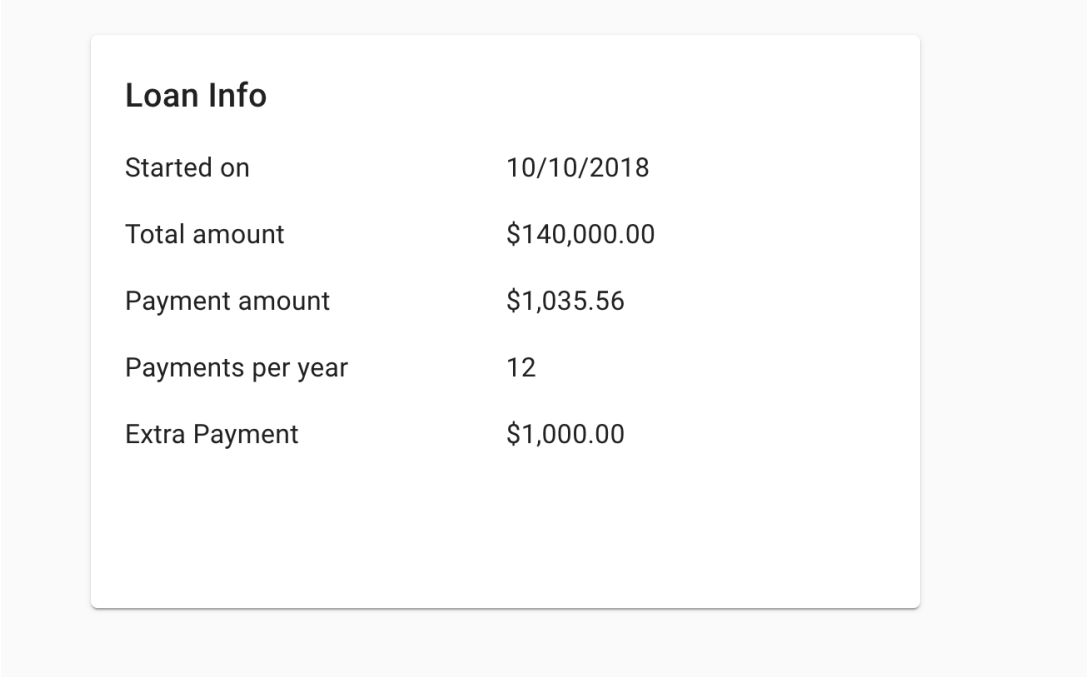
STABLE VARIABLE

APPLICATION - LOAN WEBSITE

Loan Website

Viewing Loan Attributes for a Specific Date

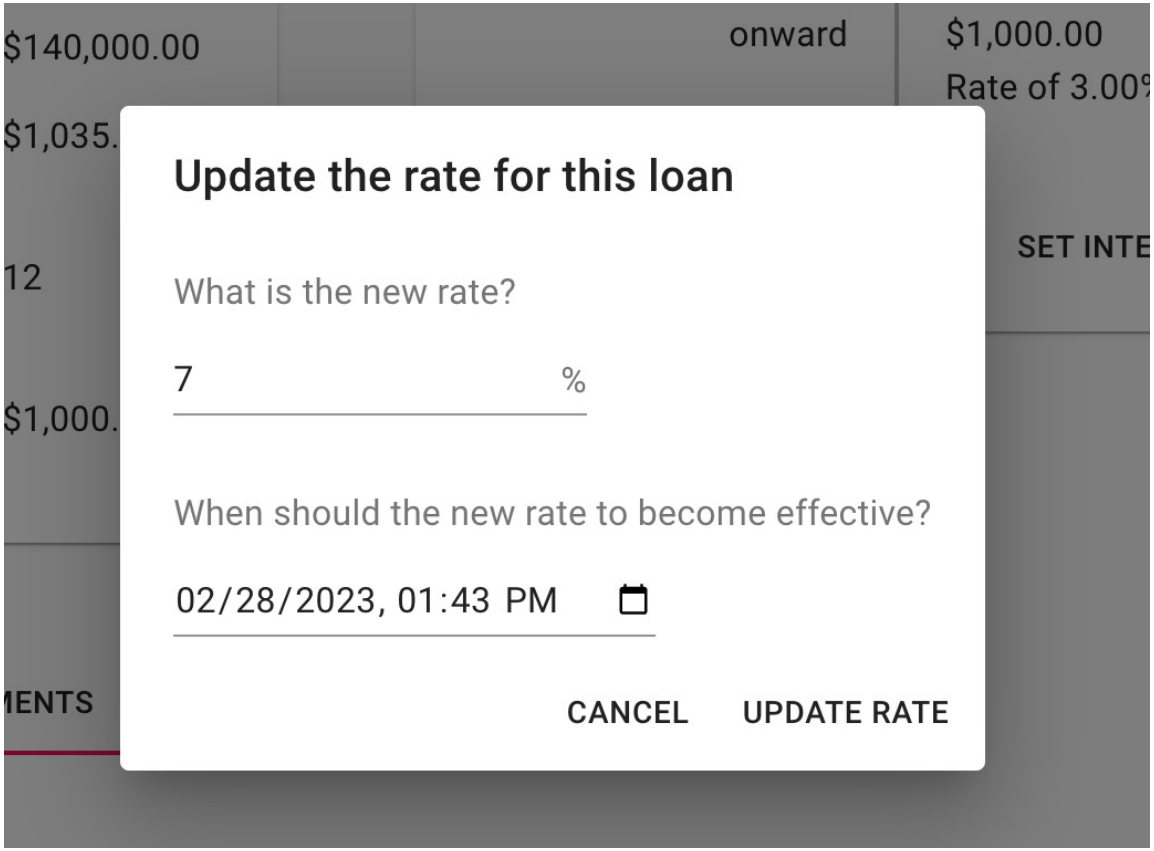
“Tell me about my loan as of today. I want to know the total principal and the extra payment.



Loan Website

Setting Loan Attributes for a Future Date

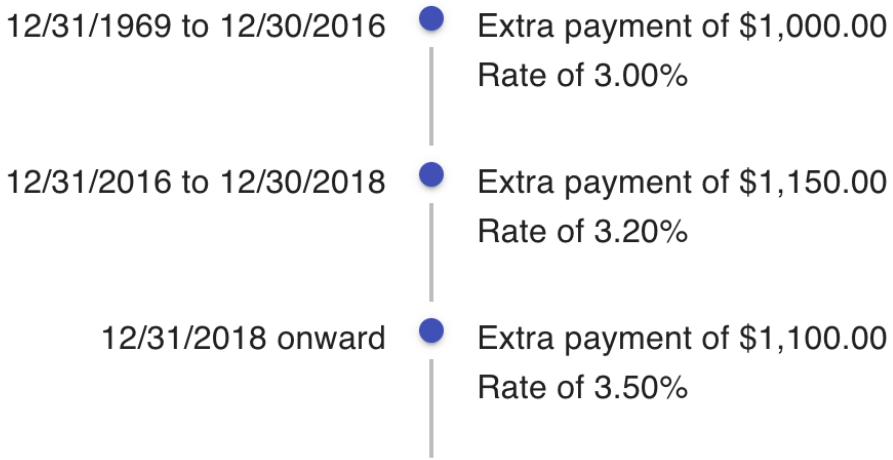
“This upcoming February the interest rate on the loan will increase to 7%.”



Loan Website

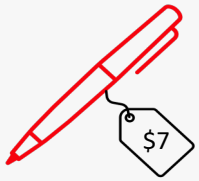
Viewing Timeline of Attributes that Change Over Time

“Tell me about my loan. I want to know what the historical interest rate and extra payment has been.”



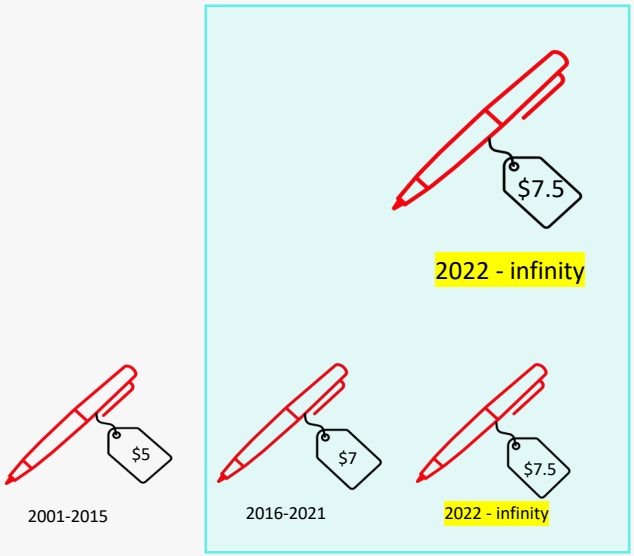
APPLICATION – MODELING FUTURE SCENARIOS

2001-2015



2016-infinity

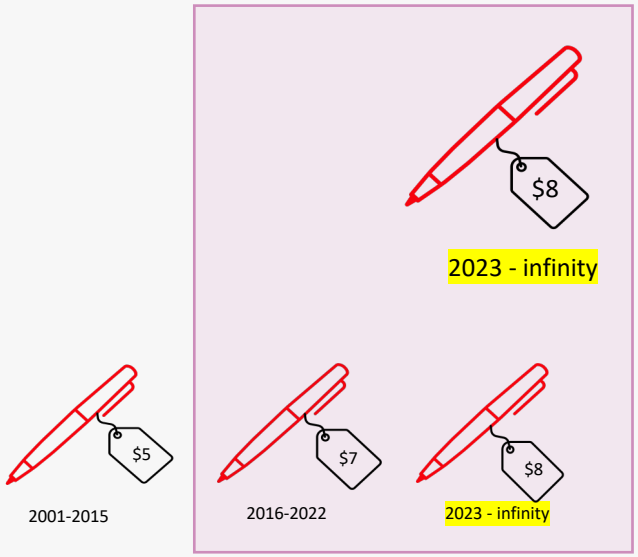
Sandbox A



Projected Revenue until 2025:
$100,500

…

Sandbox B



Projected Revenue until 2025:
$105,200

…

My blogposts on this topic:

https://spin.atomicobject.com/author/lydia-cupery/